BANK OF CANADA
BANQUE DU CANADA

Discussion Paper/Document d'analyse
2015-6

Public Policy Objectives and the Next Generation of CPA Systems: An Analytical Framework

by James Chapman, Jonathan Chiu, Sajjad Jafri and Héctor Pérez Saiz

www.bank-banque-canada.ca

Bank of Canada Discussion Paper 2015-6

September 2015

Public Policy Objectives and the Next Generation of CPA Systems: An Analytical Framework

by

James Chapman,[1] Jonathan Chiu,[2] Sajjad Jafri[1] and Héctor Pérez Saiz[3]

[1]Canadian Payments Association
jchampan@cdnpay.ca
sjafri@cdnpay.ca

[2]Funds Management and Banking Department
Bank of Canada
jchiu@bankofcanada.ca

[3]Financial Stability Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
perh@bankofcanada.ca

Bank of Canada discussion papers are completed research studies on a wide variety of technical subjects relevant to central bank policy. The views expressed in this paper are those of the authors.
No responsibility for them should be attributed to the Bank of Canada or the Canadian Payments Association.

ISSN 1914-0568

© 2015 Bank of Canada

Acknowledgements

We thank Neville Arjani, Miguel Molico, Doug Kreviazuk, Carol Ann Northcott, Carol Brigham, Paul Miller and Michael Tompkins for their contributions as well as colleagues at the Canadian Payments Association and the Bank of Canada who actively engaged in this work.

Abstract

The payments landscape in Canada is rapidly changing and will continue to evolve, fuelled by strong and persistent drivers. In Canada, the Canadian Payments Association (CPA) is on a path to modernize Canada's core payment systems. This paper contributes to the discussion in three ways. First, it translates the government's public policy objectives (PPOs) for the broad payments ecosystem into desired outcomes for CPA payment systems. Second, it develops a taxonomy for clearly describing the defining attributes of a payment system. These defining attributes are access, functionality, interoperability, timeliness of payments and risk management. Finally, we develop an analytic framework to consider the trade-offs of the various attributes to achieve the PPOs for the Canadian payments ecosystem. A key output of these contributions includes a possibilities frontier that represents the set of systems with designs that best achieve the PPOs, subject to regulatory and technological constraints. Based on the results of this exercise, we recommend the most critical issues for the CPA to investigate as it considers the modernization of its systems.

JEL classification: E42, L14, L15, L52
Bank classification: Payment clearing and settlement systems; Economic models; Financial system regulation and policies; Financial services

Résumé

L'environnement dans lequel les paiements sont effectués au Canada connaît une transformation rapide et continuera d'évoluer sous l'impulsion d'importants facteurs inscrits dans la durée. Au Canada, l'Association canadienne des paiements (ACP) s'est engagée dans une modernisation des systèmes de paiement de base. Ce document d'analyse apporte un triple éclairage. Il traduit tout d'abord les objectifs visés par les autorités publiques à l'égard de l'écosystème canadien en résultats que devront atteindre les systèmes de paiement exploités par l'ACP. Il établit ensuite une grille de critères qui précise les principaux attributs d'un système de paiement, à savoir l'accès, la fonctionnalité, l'interopérabilité, les délais entre l'envoi et l'irrévocabilité des paiements, et la gestion des risques. Enfin, un cadre d'analyse est mis au point pour l'examen des arbitrages à exercer entre les différents attributs en vue de réaliser les objectifs des autorités publiques à l'égard de l'écosystème canadien des paiements. L'une des principales dimensions de ces divers apports est la définition d'une frontière de possibilités qui représente un groupe de systèmes dont les caractéristiques répondent le mieux aux objectifs des autorités, compte tenu d'un ensemble de contraintes réglementaires et technologiques. Les résultats obtenus au terme de cet exercice fondent la base des recommandations adressées à l'ACP sur les considérations qu'elle devra examiner en priorité dans le cadre de la modernisation de ses systèmes.

Classification JEL : E42, L14, L15, L52
Classification de la Banque : Systèmes de compensation et de règlement des paiements; Modèles économiques; Réglementation et politiques relatives au système financier; Services financiers

1. Introduction

The payments landscape in Canada is rapidly changing and will continue to evolve, fuelled by strong and persistent drivers. Among these,

- user demands for fast, secure and information-rich payments are driving innovation, which is being met by technology and standards advancements in the retail space (e.g., payments through mobile devices) and the wholesale space (e.g., providing more efficient liquidity and risk-management tools);
- new players in the retail payments system, such as ApplePay and Shopify, are leveraging technology to enter new markets and transform the payments experience for consumers and businesses;
- globalization has increased the demand from corporations and financial institutions for an efficient and effective cross-border payments experience as well as straight-through processing of payments; and
- finally, coming out of the 2007–09 financial crisis and given the rapid evolution of the retail payments space with new technologies and new players, regulators and public authorities are holding financial market infrastructures (FMIs) to more stringent regulations and standards for risk management.

It is therefore not surprising that, around the world, there is a global trend to renew clearing and settlement systems to keep pace with these changes.[1]

In Canada, the Canadian Payments Association (CPA) is on a path to modernize Canada's core payment systems. The CPA operates Canada's main clearing and settlement systems for retail and wholesale payments. These systems underpin the Canadian financial system and economy. Given the importance of these systems, the CPA has a legislative mandate to operate these systems in a way that achieves the Canadian government's public policy objectives of safety and soundness, efficiency and meeting the needs of users. [2]

As part of the modernization initiative, the CPA is developing a shared vision for the future of the Canadian payments ecosystem with CPA member institutions, payment system users and service providers. This will allow the CPA to anticipate the changing needs of industry and society and position itself to enable innovative products and services to emerge that best meet the public policy objectives.[3]

Of course, to do this, it is necessary to understand what the public policy objectives mean for CPA payment systems and develop a payment system design that has attributes that best meet the public policies objectives and support the needs of CPA's members and stakeholders.

---

[1] See CPA (2014) for more information on the drivers and trends in the global and domestic payments landscape.

[2] As per section 5(2) of the Canadian Payments Act, in pursuing its objects, the CPA shall "promote the efficiency, safety and soundness of its clearing and settlement systems and take into account the interests of users."

[3] See CPA (2015) for more information on the CPA's modernization initiative.

This paper contributes to the development of a shared vision of modernization in several ways.

First, the government's public policy objectives for the broad payments system are translated into desired outcomes for CPA payment systems.

Second, a taxonomy is developed for clearly describing the defining attributes of a payment system. In practice, there are many possible design features and practitioners often use terms in different ways. We articulate five high-level attributes that can be used to describe any given payment system. This provides a consistent foundation for developing the "shared vision." The defining attributes are **access, functionality, interoperability, timeliness of payments** and **risk management**. A payment system can be described in terms of different levels and combinations of the attributes. These attributes have direct and indirect effects on achieving the public policy objectives.

The third contribution of this paper, and an important innovation, is the development of an analytical framework to systematically consider the trade-offs of the various attributes to achieve the public policy objectives (PPOs) for the Canadian payments ecosystem. We develop a "possibilities frontier" that represents the set of systems that have designs that best achieve the PPOs subject to regulatory and technological constraints.

This framework is used to recommend the most critical issues for the CPA to investigate as it develops its "shared vision." There are myriad design options for a payment system; this approach helps sort through the choices in a rigorous manner. Using the analytic framework, we recommend three key areas of investigation that will best position the CPA to design a core payment system that best meets the public policy objectives and, thereby, the needs of Canadians:

- Systems that best achieve the public policy objectives enable ***rich functionality***. For example, they may have the ability to provide and support value-added services such as rich messaging, modern queuing mechanisms and centralized services that allow the back offices of participants to be more efficient. This finding has two implications. First, the CPA should focus on identifying the most relevant value-added services for the Canadian payments ecosystem. That is, it should identify the most important user demands. Second, in order to continue to be a system that best achieves the public policy objectives over time, the next generation of core payment systems should be designed in such a way that they continue to be effective in an evolving payments landscape. That is, given rapidly evolving technological advances, the CPA will need to consider how best to design the core so that it can support innovation over time and thereby remain on the frontier longer of what is possible.
- The same mix of public policy objectives can be achieved through different combinations of system access and interoperability, all else constant. For example, the reduction in efficiency that would otherwise emerge from a decline in interoperability can be partially or fully offset by enhanced access, and vice-versa. Given that the payments ecosystem is changing rapidly with new players entering the retail payment space, the CPA will need to consider how to best enhance efficiency through access and interoperability for a given level of safety.

- Retail system designs that best achieve the public policy objectives can have varying degrees of timeliness of payments. This finding is important because, in many jurisdictions, a driver of modernization has been a desire for "faster payments." Our work suggests that a system can meet the public policy objectives with different levels of timeliness. Therefore, it will be important for the CPA to understand where there is a real demand for more timely payments in the Canadian context.

Finally, this paper does not address the architectural design of the core payment system, for example, whether the core payment system should be centralized in one organization or be a decentralized system between members, or whether there should be one system or separate systems for wholesale and retail payments. As the CPA determines the desired attributes, there will be implications for the structural schema.

The remainder of this paper is organized as follows. Sections 2 and 3 describe the analytical framework. Section 4 draws out the insights from the parametrization exercise. Section 5 applies the framework to the Canadian core payment systems and section 6 expands on the discussion and provides next steps.

2. Building the Analytical Framework

2.1 Overview

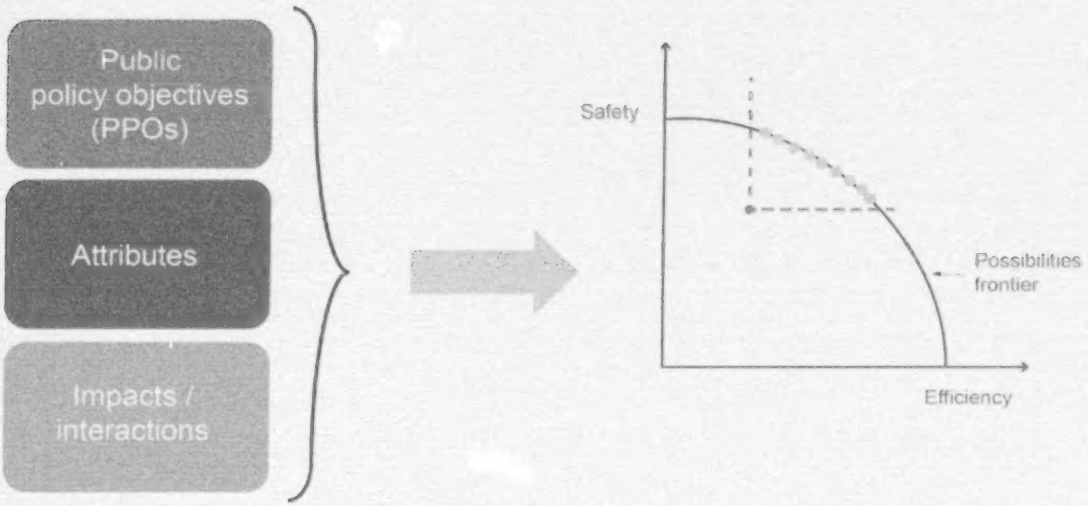
The analytical framework is grounded in earlier research by Berger, Hancock and Marquardt (1996), which uses a stylized general equilibrium setting to highlight common trade-offs emerging between PPOs in the design of payment systems. The authors illustrate these trade-offs using the notion of a "payments possibilities frontier" and discuss the role of financial, technological and regulatory innovation in shaping and positioning the frontier over time.

Building the analytical framework requires answering the following questions:

- Given the PPOs for the broad payments ecosystem, what are the expectations for the Canadian core payment systems?
- What are the defining attributes of a core payment system?
- How do the defining attributes enable a system to meet the PPOs, taking into account potential direct and indirect (interaction) effects between attributes?

These inputs to the analytical framework, as well as the expected outcome of the framework, are illustrated in Figure 1 below.

Figure 1: Conceptual diagram of the analytical framework



We begin by selecting defining attributes that can be used to describe, evaluate and compare any core payment system design. The analytical framework then maps the attributes of any technically feasible core payment system design to a point in the PPO space, taking into account direct and interaction effects. The possibilities frontier represents the set of system designs that attain the highest possible level of the PPOs, subject to current regulatory and technological constraints. In other words, along the frontier, technical efficiency is achieved because the same payment clearing and settlement activity cannot be produced more safely without compromising efficiency, and vice versa.[4] Points inside the frontier represent technical inefficiency—the same payment clearing and settlement activity could be produced more safely or efficiently, or both. Points above and to the right of the frontier represent system designs that are unattainable given current constraints. Over time, however, as these constraints are relaxed through innovation, the frontier should drift further from the origin, making some of these points technically feasible.

At the time of their inception, it is plausible that the CPA's retail system (the ACSS) and wholesale system (the LVTS) were on or near the frontier, representing the "state-of-the-art" in system design.[5] Over time, however, innovation is expected to have pushed out the possibilities frontier in Canada, situating the ACSS and LVTS below and to the left of the frontier (illustrated by the hypothetical red dot in Figure 1). We use the analytical framework to provide a perspective on the possibilities frontier in Canada, to position the ACSS and the LVTS in relation to that frontier, and to identify key issues to investigate to modernize the CPA systems in a way that best meet the PPOs.

[4] For illustrative purposes, only two of the three PPOs are shown in Figure 1. Actual results from the analytical framework consider all three PPOs.

[5] The Automated Clearing Settlement System and Large Value Transfer System, respectively.

2.2 Scope of the analysis: Defining Canadian core payment systems

Our analysis is focused on the core payment clearing and settlement systems in Canada—those systems that form the backbone of the financial system.[6]

For this work, a core payment system is defined as one that (i) includes at least clearing and settlement, where settlement occurs in central bank funds,[7] and (ii) is central to the efficiency and stability of the Canadian financial system and the Canadian economy.

The first part of the definition acknowledges that, at a minimum, core systems provide clearing and settlement functions that underpin payment activity. Given the importance of these systems, they tend to settle in central bank funds to support finality of payments.[8] The second part of the definition implies that a system must meet a minimum level of importance in the payments ecosystem to be considered a core system.

Finally, core systems typically exhibit strong network externalities and economies of scale because of the fixed cost of building the system and of being a participant and the low marginal cost of providing the service. These two features imply that market forces alone cannot be counted on to provide the best outcome for Canada in providing core payment services and therefore a non-market or collaborative approach makes sense when designing core systems.

In the current Canadian context, the LVTS and ACSS meet this definition of "core" payment systems. Together they account for 99 per cent of the value and 67 per cent of the volume of payments cleared and settled in Canada. Any reference to CPA systems hereafter focuses exclusively on their role in supporting the core functions of clearing and settlement.[9]

2.3 Public policy objectives

Given the importance of the payments ecosystem to the economy, the Canadian government has a keen interest in its development. The government has identified three public policy objectives (PPOs) that should be achieved by the Canadian payments ecosystem: (i) safety and soundness, (ii) efficiency, and (iii) meeting the needs of Canadians[10] and protecting their interests. [11] For simplicity, we refer to them as safety, efficiency and end-user interests.

---

[6] We use the term "payment system" to include the relevant technology, rules and standards, and legal framework.

[7] The whole payment processing cycle includes origination, authentication, exchange, clearing and settlement. While a core system could carry out other parts of the payment processing cycle, it must, at a minimum, perform clearing and settlement.

[8] Settlement in central bank money avoids the credit and liquidity risk (often called "banker risk") that exists if settlement happens across the books of a commercial bank.

[9] That said, the CPA's service offering to the payments ecosystem could extend beyond the core functions of clearing and settlement. The CPA Services Network, or CSN, which facilitates origination and exchange of AFT (automated funds transfer) debit and credit payments, as well as EDI (electronic data interchange) payments, serves as a current case in point.

[10] This includes consumers, businesses and governments, as well as participants and entities operating a payment system in their capacity as a business.

[11] See Department of Finance (2015) for more information on the Canadian government's public policy objectives for the Canadian payments ecosystem.

Safety refers to how a given payment system appropriately manages and controls risks (legal, credit, liquidity, operational and business). Safety is a key objective since it is an essential condition to achieve a stable financial system and a well-functioning economy. Given the potential to transmit negative shocks, core payment systems must be operated with appropriate regard to safety and soundness and are subject to internationally recognized supervision standards.[12]

Efficiency refers to how effectively the payment clearing and settlement processes are carried out to meet end-users' needs, as well as ensuring the efficient allocation of resources to deliver the service. This PPO has two main, closely related features. First, it seeks to ensure that competitive market forces are fostered and barriers to entry are removed. Second, using market forces and competition, it encourages innovation and achieves cost reductions. Two of the outcomes that the government is targeting are that the core payment system supports competition and innovation further down the payments supply chain and that there are no network or participant abuses of market power.

The PPO "end-user interests" deals with the larger payments ecosystem and aims to ensure that payment systems operate to the benefit of end-users. In terms of our framework, this means understanding how the attributes of a core payment system can help the larger ecosystem achieve this objective.

Some of the outcomes that the government is targeting with this objective are ensuring that there are no undue barriers to end-users switching providers and that end-users have an effective channel to participate in the development of payment systems.

Table 1 presents a summary of the PPOs as they apply to the payments ecosystem, as well as some desired outcomes for the design of the next generation of core payment systems.[13]

Table 1: Public policy objectives and related considerations for the design of core payment systems

Objective	Definition	Selected desired outcomes
Safety and soundness	Safety and soundness refer to how payment systems appropriately measure, manage and control risks, taking into account legal risk, credit risk, liquidity risk, operational risk and business risk.	• Systemically important and prominent payments systems must meet the relevant Bank of Canada standards, which are based on internationally recognized standards.[14] • Core systems must engender the confidence of Canadians and should foster their confidence in the broader payments ecosystem.

[12] The Principles for Financial Market Infrastructures (CPSS-IOSCO 2012).

[13] See Department of Finance (2015) for more information on definition and principles of the public policy objectives described in this table.

[14] For more information, see http://www.bankofcanada.ca/core-functions/financial-system/oversight-designated-clearing-settlement-systems.

Efficiency	Efficiency in payment systems includes how effectively the payment clearing and settlement processes are carried out to meet end-users' needs, as well as ensuring the efficient allocation of resources to deliver the service.	• Access to core systems should be based on objective risk-based requirements. • Core systems should be able to adapt to the evolving payments landscape from the perspective of technology standards and should not limit the CPA's ability to accommodate new payment types that meet minimum requirements, i.e., they should be agnostic to payment type. • Core systems should endeavour to foster competition and innovation further along the payments supply chain. • Core systems should employ technical standards that facilitate interoperability of domestic and international payment systems and services. • Core systems should exploit technological innovation to minimize cost for participants.
Meeting the needs of Canadians and protecting their interests	Payment systems must be designed and operated to meet the needs of Canadians and protect end-user interests that include convenience and ease of use, price, safety, privacy and effective redress mechanisms.	• Core systems should support all eligible payment instruments that meet minimum technical or legal standards. • The core systems should not create or foster undue barriers to end-users switching between payment providers. • The core systems should foster a safe, secure and convenient environment for all Canadians to transact.

2.4 Attributes of a core payment system

To construct a framework that can evaluate and compare design possibilities for a next generation of core payment systems, one needs to be able to describe a system according to a common set of characteristics.

For the purposes of this study, the defining attributes of a core payment system are articulated in a way that would apply to any core payment system design, e.g., either wholesale or retail systems. The description is general enough to describe any system while detailed enough to allow for useful analysis.

The five defining attributes of a payment system are **access**, **functionality**, **interoperability**, **timeliness of payment** and **risk management**. These attributes provide a complete high-level characterization of any infrastructure within the core and allow us to capture relevant trade-offs between design features in the attainment of the PPOs.[15]

Table 2 presents a high-level description of each of the five attributes.

[15] As a robustness check, these five attributes generally align with those outlined by the Reserve Bank of Australia (RBA) in its Strategic Review of Innovation in the Payments System. The RBA describes the following attributes as being valued by end-users: timeliness, accessibility, ease of use, ease of integration with other processes, and safety and reliability.

Table 2: Defining attributes of core payment systems

Attribute	General description
Access	The minimum conditions that an entity would need to satisfy in order to participate directly (or indirectly) in the core payment system.
Functionality	The features embedded in the service offering of the core payment system above those needed for clearing, settlement and other aspects in the payments process.
Interoperability	At a general level, the degree of compatibility between the core payment system and other external systems.
Timeliness of payment	The time between initiation of a payment and when funds can be made available to the final recipient on an irrevocable basis, according to the payment system rules and not prevailing business practice. We call this "irrevocable availability" or "finality."
Risk management	The technology, rules, guidelines and other processes used to appropriately identify, assess and control risks across all functions of the payment system.

Access refers to the minimum conditions that an entity would need to satisfy in order to participate directly (or indirectly) in the core payment system. The level of access can vary. For example, with a low level of access (and implicitly a high level of tiering), only financial intermediaries could participate with a minimum level of volume in the system. A high level of access could allow all corporations meeting certain criteria to join if they so choose. At a more general level, access criteria may differ according to the function performed, e.g., access criteria to exchange functions may be more lenient than access to clearing functions.

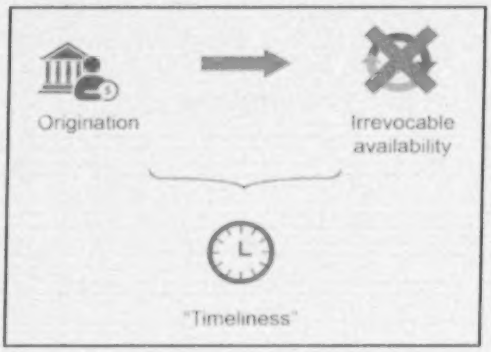
Functionality refers to the specific features embedded in the system that are intended to enhance its overall value proposition to participants and to the ecosystem more widely. These features include value-added services embedded within the clearing process where centralized provision of these services is deemed more efficient than provision by each individual institution, i.e., avoiding duplicate provision of services where scope for competition is limited. Aspects of functionality can vary from having no functionality beyond what is strictly necessary for clearing and settlement to offering a wide range of features, including a richer level of remittance information or a centralized process to provide anti-money laundering (AML) or fraud detection processes. Other aspects of functionality could include processes in the system that would help participants control their risk or liquidity better through queuing mechanisms or additional monitoring tools.

Interoperability refers to the degree of compatibility between the core payment system and other external systems or schemes (including participant back-office systems) in carrying out the payments process. Interoperability encompasses a domestic and international dimension. In a domestic context, this includes the degree to which a system is able to support straight-through-processing (STP) of payments from sender to beneficiary and foster automated reconciliation of payments. It also includes the degree to which a system is integrated with external systems, for

example, participant back-office systems and other financial market infrastructures (FMIs). In an international context, interoperability refers to the degree to which a national system is integrated with other international FMIs to support cross-border payments activity.

Timeliness of payment refers to duration between origination of payment by the sender and when the funds can be posted to the account of the beneficiary on an irrevocable basis (see Figure 2 below), according to the infrastructure rules and not prevailing business practice. Timeliness of payments has two aspects—the hours of operation of the core systems and how fast a payment is considered "irrevocable" or "final" when the system is running. A system that is open for only a short period and/or provides "finality" only once a day (or less) would have a low level of timeliness. Conversely, a system with a very high level of the timeliness would provide real-time finality and be operational 24 hours a day, 7 days a week.

Figure 2: Definition of timeliness



Risk management refers to the technology, rules, guidelines and other processes used to appropriately identify, assess and control risk across all functions of the infrastructure. While there are a multitude of risks in a payment system (e.g., operational risk, liquidity risk and legal risk), a key risk is credit risk, since the presence of credit risk in payment instruments hinders their usefulness.[16] In addition, credit risk management is a distinct choice in payment system design. Systems that have a high degree of credit risk management are typically real-time gross settlement (RTGS) or RTGS-equivalent systems with little intraday credit. These systems have sufficient resources for all payments to settle regardless of any possible defaults of participants. A system with a low degree of credit risk management would be a deferred net settlement system with relatively high intraday credit.

Each attribute is viewed from the perspective of baseline requirements and design considerations, which are articulated in tables A1 to A5 in the Appendix.

Baseline requirements reflect minimum requirements for any next generation core payment systems, i.e., the "must haves" stemming from regulatory and oversight requirements, etc.

Design considerations are where there is greater discretion. Each design consideration is accompanied by a list of design options. These considerations and options give rise to alternative system designs for evaluation and comparison as part of the analytical framework.

2.5 Cost considerations

While cost is excluded as a defining attribute, it is captured in several ways. System cost is evaluated on a *going-concern* basis; build costs are excluded. Cost is implicitly captured in the five defining attributes and is embedded directly in the PPO of efficiency. For example, a system

[16] See Gorton (2010) for a discussion of why risk-free debt is essential for a well-functioning financial and payment system.

exhibiting a high degree of risk management would be relatively more costly to participate in compared with one with a low degree of risk management, all else equal. Moreover, having cost embedded in the PPO of efficiency implies that the design of the next generation of core payment systems considers the cost implications for all Canadians, as well as these systems' influence on competition and innovation in downstream markets.

3. An Analytical Framework of the Trade-offs in Core Payment Systems

In designing a payment system, one is faced with important trade-offs between different system attributes in order to achieve the public policy objectives. The analytical framework provides a structured approach to understanding these trade-offs.

The framework maps a given set of attributes into each of the PPOs. This mapping is a function of both the attribute as well as any interactions among the attributes. *Direct effects* relate to the contribution of each individual attribute to the system's ability to meet desired outcomes for a PPO, *holding all other factors constant. Interaction effects* are more challenging since they capture interrelationships between attributes in contributing to the ability of a system to meet desired outcomes.

This approach allows us to take into account complementarities between different attributes (e.g., a high level of timeliness is complementary to credit risk management) or disallow certain combinations of attributes that are inherently contradictory.

The framework can be represented by the following system of equations:

$$(1)\ E(a) = \sum_{i=1}^{5}(\omega_i^E)^2 f_i^E(a_i) + \sum_{i=1}^{5}\sum_{j=1}\omega_i^E\omega_j^E f_{i,j}^E(a_i, a_j)$$

$$(2)\ S(a) = \sum_{i=1}^{5}\left(\omega_i^S\right)^2 f_i^S(a_i) + \sum_{i=1}^{5}\sum_{j=1}^{5}\omega_i^S\omega_j^S f_{i,j}^S(a_i, a_j)$$

$$(3)\ U(a) = \sum_{i=1}^{5}\left(\omega_i^U\right)^2 f_i^U(a_i) + \sum_{i=1}^{5}\sum_{j=1}^{5}\omega_i^U\omega_j^U f_{i,j}^U(a_i, a_j)$$

In equations (1) to (3), prospective core payment systems are "scored" on their ability to meet desired outcomes relating to each PPO. Scores are presented on the left-hand side of each equation, denoted as $E(a)$, $S(a)$ and $U(a)$ for efficiency, safety and user interest, respectively. Each equation shows the score for a PPO as a function of the five defining attributes, $a = (a_1, a_2, a_3, a_4, a_5)$, and encompasses both direct and interaction effects. Direct and interaction effects are themselves presented as functions in each of the three equations—f_i^A and $f_{i,j}^A$ —where superscripts reference PPOs and subscripts reference attributes. The right-hand side of each equation is calculated as the sum of the weighted-averages for each type of effect.

For example, consider what would inform the parametrization of equation (2) for the safety PPO. One would expect that the higher the degree to which a system employs technology, rules and procedures to manage settlement risk (e.g., real-time settlement, prudent controls on intraday credit provision, centralized queuing and optimization, etc.) the higher its safety. That is, a positive

relationship is expected between the degree of risk management employed by the system and its ability to meet the PPO of safety.

An often-cited example of interaction (i.e., the second term of an equation) is one where a higher level of access to the system (e.g., allowing corporations of any size and risk profile direct access to the system) presents more of a safety concern in an uncollateralized deferred net settlement (DNS) environment than in an environment characterized by real-time gross settlement (RTGS) with collateralized or appropriately priced intraday credit provided by the central bank. That is, the interaction between the attributes of access and credit risk management should be captured in the second term of equation (2).

It is necessary to consider the precise nature of the direct and interaction relationships to inform the functional forms used in equations (1) to (3). For example, are these relationships linear or non-linear? If non-linear, do they exhibit diminishing returns? These questions are addressed through the operationalization and parametrization of the framework.

Once parametrized, the system of equations will allow any system to be scored on how well it supports each PPO and will also facilitate comparison between systems in this regard.

3.1 Operationalizing the framework

Operationalizing the analytical framework so that it can provide guidance requires modelling assumptions and the parametrization of the above equations.

First, minimum baseline characteristics were determined for each attribute. These baselines stemmed from either minimum regulatory requirements or technological constraints.[17] Once the minimum baselines were decided, the remaining design considerations and options were mapped into a five-point set for each attribute. This provides flexibility in modelling the effects of attributes but limits the potentially infinite combinations of attributes to be examined. The results of this mapping are shown in Table 3. With five defining attributes and five possible scores for each attribute, there are approximately 3,000 core payment system design possibilities for evaluation and comparison.

[17] We articulated the baseline requirements in a way that allows for different approaches to operationalization in subsequent stages of the CPA's modernization project.

Table 3: Five-point attribute sets

Attribute	Criteria for 1–5 ranking (1 = Low; 5 = High)
Access	**(1)** Banks **(2)** (1) + Non-bank deposit-taking institutions **(3)** (2) + Non-deposit-taking financial institutions **(4)** (3) + Payment service providers **(5)** (4) + Non-financial corporations
Functionality	**(1)** Individual clearing format, no value-added services **(2)** Batch clearing format, no value-added services **(3)** Batch or individual clearing format, low level of additional value-added services **(4)** Batch or individual clearing format, medium level of additional value-added services **(5)** Batch or individual clearing format, high level of additional value-added services
Interoperability	**(1)** Minimum of low domestic, low international **(2)** Minimum of medium domestic, low international **(3)** Minimum of medium domestic, medium international **(4)** Minimum of high domestic, medium international **(5)** High domestic, high international
Timeliness of payment	**(1)** T+2 or later **(2)** Next day **(3)** Same day **(4)** Multiple intraday **(5)** Real time or near real time
Risk management	**(1)** Deferred net settlement (DNS), same-day or later settlement, uncollateralized intraday credit and no central bank guarantee; partial or full unwind in the event of participant default **(2)** DNS, same-day or later settlement, uncollateralized intraday credit and no central bank guarantee; system rules dictate how to allocate losses ex post to survivors **(3)** DNS, same-day or intraday settlement, collateralized to withstand a single default **(4)** Real-time gross settlement (RTGS), collateralized (or priced) intraday credit provided by central bank; *or* DNS, same-day or intraday settlement, with guaranteed settlement[18] **(5)** Pure RTGS, no intraday credit provision by the central bank

Note: The options articulated here are beyond the baseline requirements described in tables A1 to A5 in the Appendix.

With this five-point, five-attribute system, we are able to describe systems as a vector of the levels of the five attributes. For example, the LVTS maps to [3, 3, 3, 5, 4] because its membership may include non-deposit-taking financial institutions; it has a medium level of functionality (i.e., a queuing mechanism, web enablement and real-time position monitoring); it has a medium level of interoperability; and it is an RTGS-equivalent system, which implies it is a cover-all system that

[18] Acceptance of either RTGS or DNS in this score category recognizes the trade-off that exists within the notion of "settlement risk" between credit risk and liquidity risk. DNS compares favourably on the latter risk by providing more efficient use of collateral in settling payments. In contrast, RTGS compares favourably on the former risk by reducing counterparty credit risk in the settlement system. It is difficult to determine in general which risk is more critical to broader settlement risk; this will depend on the specific details of a system.

settles in real time. The mapping for ACSS is [2, 2 2, 2, 2] based on its more restrictive access criteria (i.e., minimum volume requirements), its batch total clearing format and limited functionality, its lack of interlinkages with other FMIs and STP capabilities for certain payment streams, its next-day availability of funds, and because it is an uncollateralized DNS settlement system.

3.2 Parameterizing the framework

We parameterize the weights (ω) of the attributes and the functional forms (f_i^A and $f_{i,j}^A$) in the framework's three equations by gathering mostly qualitative data from a variety of information sources.

The initial step in gathering information was a thorough review of the academic literature on payment systems, followed by an environmental scan of payment systems in other jurisdictions, which will be published in a companion paper.[19]

The second step was to conduct a series of focus groups inside the CPA and the Bank of Canada to elicit expert opinions about the various effects and weights. These meetings included a cross-section of staff from the payments operations, legal, policy and research areas in order to capture institutional knowledge embedded within the two organizations.

The final step was to use the five-point attribute sets of LVTS and ACSS with the parameterized framework to produce their rankings relative to the three PPOs. We used this ranking along with our institutional knowledge of the LVTS and the ACSS to validate the parameterization. For presentation convenience, the parameter values and functional forms obtained are not reproduced in the paper but are available upon request.

4. Insights from the Parameterization Exercise

The parameterization process elicited many insights from our experts and research on the trade-offs between attributes for each PPO. For example, a well-documented trade-off in the payment economics literature is between safety and efficiency.[20] Below we elaborate on these insights. In particular, we identify important attributes for each PPO, in the sense that they could have either a significant positive or negative impact on the PPO.

4.1 The most important attributes for efficiency are functionality, interoperability and access

The two fundamental components of efficiency are (i) the social cost of the payment system and (ii) the amount of competitiveness in the payment system. From a pure social cost perspective, the attributes that enhance efficiency are those that lead to more cost-effective processing or allow for beneficial innovations in the payment system.

In parameterizing the framework, we find that the most important attributes for efficiency are functionality and interoperability, followed closely by access to the payment system. All three of

[19] The list of references in our academic review of the literature is available upon request.

[20] See, for example, Berger, Hancock and Marquardt (1996).

these attributes improve competitive efficiency by reducing barriers to entry into the payment system and allowing more sophisticated payment messages. In contrast, the attribute that appears to contribute the least to efficiency is timeliness of payments, followed by credit risk management.

Increased functionality is important for increased efficiency since it

- allows for the introduction of new payment system instruments and services, increasing potential profitability, which would give firms the incentive to enter the payment system market and innovate to provide value-added services to customers;
- can increase efficiency at the wholesale level through the introduction of tools for liquidity management such as queues and other liquidity savings mechanisms; and
- provides services that, for example, allow for better management of payment flows or increased cost savings by potentially reducing duplication of regulatory processes, such as AML or fraud detection, across payment system participants.

Access increases the threat of entry into payment system processing, which in turn increases competition.

With respect to interoperability, a system that enables STP and fosters automated reconciliation (for example, through the use of the ISO 20022 message standard) or that facilitates clearing and settlement of other FMIs is expected to contribute to cost savings that flow all the way through to end-users.[21]

There are some interesting interaction effects. For example, less competition caused by low levels of access could be mitigated by increased interoperability. In particular, increased standardization reduces the "locked-in" impact of more restricted access. Reduced competition could also be mitigated by higher functionality, for example, through proxy databases that facilitate account switching. Conversely, the competitive benefits of high levels of access could be blunted by low interoperability and low functionality, since customers of payment system participants could be "locked-in" to their payment system provider because of the lower compatibility and standardization across providers.

Certain attributes impede the efficiency gains described above. As timeliness of payments increases, it reduces the potential for beneficial services such as centralized AML and fraud detection processes. As well, given that a faster payments solution would likely preclude batch clearing in favour of an individual credit transfer clearing format, any efficiencies brought about by pre-settlement netting could be foregone. Lastly, a high intensity of risk management is also expected to detract from system efficiency, on the grounds that risk-proofing entails added cost to participants, which is possibly passed down to end-users.

In sum, the parameterization finds that a typical high-efficiency system in our framework should have high functionality and interoperability, and high access if warranted, but it may not have "timely" payments. That is, it may not support real-time, irrevocable availability of payments.

---

[21] This reflects both a financial and opportunity cost component. See N. Arjani. 2015 (forthcoming). "The Economic Benefit of Adopting the ISO 20022 Payment Message Standard in Canada." CPA Discussion Paper.

4.2 The most important attributes for safety are risk management, access and timeliness of payments

Not surprisingly, the most important attribute that contributes to safety is risk management. The second most important attribute for safety is access, since high levels of access can introduce relatively high-risk firms as direct participants. Of course, this could be offset by more explicit risk-management controls.

The remaining three attributes have a lesser (but not immaterial) impact on safety:

- There is an important interaction between credit risk management and timeliness. When timeliness is "high" (i.e., there is a short duration between origination and irrevocable availability), levels of risk management tend to be high since this reduces the exposure to counterparty credit risk. Payments that are settled with real-time finality do not expose a receiver to counterparty credit risk, while in a netting system, there may be credit exposures over the day. Together, these two attributes guarantee a reduction in both the amount and duration of this risk.
- Functionality could increase safety through an increased ability to manage payment system activities such as liquidity management.
- Interoperability potentially exposes the payment system to risks in other parts of the financial system through contagion or increased operational risk because of the interconnection between systems.

4.3 The most important attributes for end-user interests are timeliness, interoperability and access

All attributes of a payment system contribute to enhancing end-user interests. The three key attributes are, in order of importance, timeliness, interoperability and access.

End-users are less concerned about the underlying workings of the payment system. They are mainly interested in sending and receiving funds with finality, in a timely cost-effective manner, and at low risk to their personal and financial security. The key aspect that they care about is the speed with which they can receive their funds. Therefore, timeliness is the most important attribute, followed by interoperability since characteristics such as STP make it easier for end-users. Higher levels of access or functionality facilitate a more competitive and innovative market that offers more and better services to end-users.

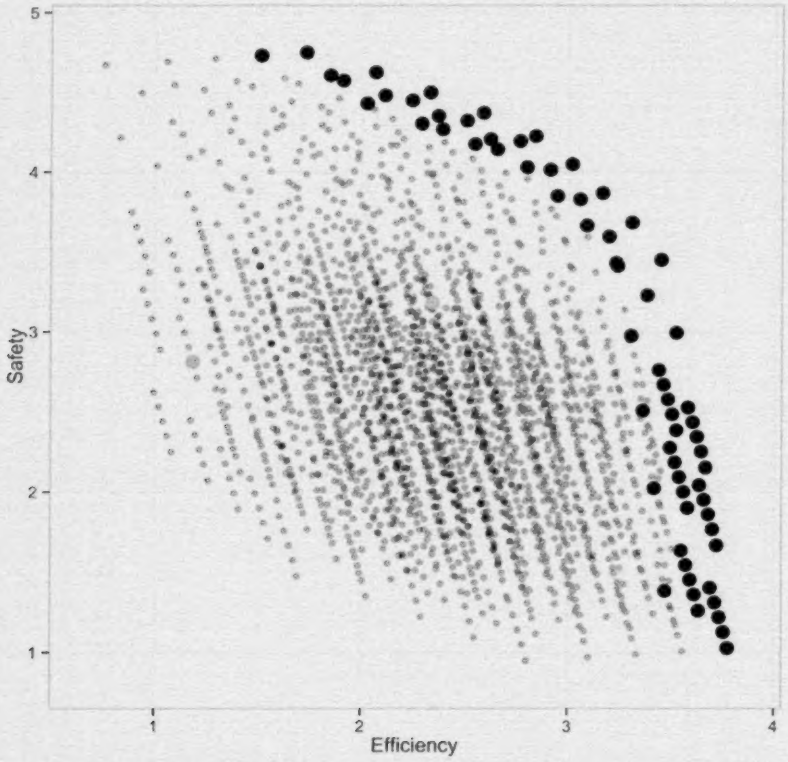
In sum, a payment system emphasizing the PPO of end-user interests would offer real-time finality, end-to-end STP and access to a wide variety of participants. This implies a system exhibiting the attributes of high timeliness, high interoperability and high access. As such, functionality would also be of some importance since it would include fraud detection services that would serve end-user interests—to the extent that these services could be provided in a real-time, transaction-based clearing format.

5. Applying the Framework to the Core Canadian Payment Systems

The framework is used to derive the possibilities frontier—the set of system designs that best achieve the PPOs subject to current regulatory and technological constraints (Figure 3). Furthermore, the current core Canadian payment systems—ACSS and LVTS—are placed in this space. The set of attributes reflective of the ACSS and LVTS are highlighted in red and blue, respectively, to show how these two systems compare in terms of safety and efficiency.

While systems have been scored against all three PPOs, the results are projected in the two-dimensional space of safety and efficiency for ease of reading. The ACSS and LVTS score closely together against the safety PPO, which might not be intuitive. This is because, in the parameterization, safety increases with risk management, but decreases with access and interoperability. While the LVTS scores high against the risk-management attribute, the ACSS scores relatively low from an access and interoperability perspective, and these competing factors are driving the result depicted in Figure 3 for the two systems.

Figure 3: How core payment system designs perform in terms of safety and efficiency

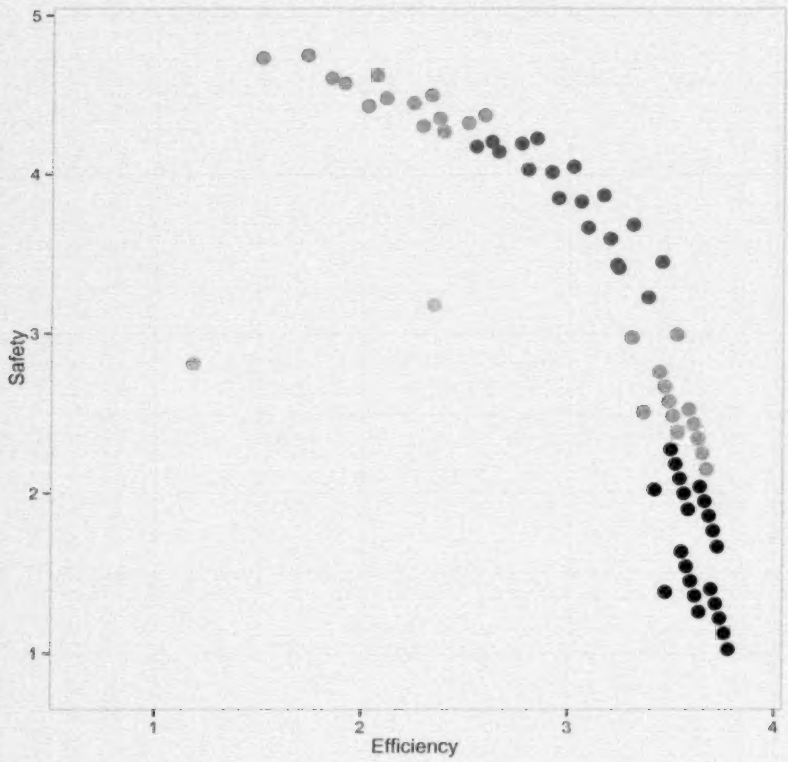


Note: This plot contains all possible combinations of different attribute levels. The combination of attributes corresponding with the existing systems of LVTS and ACSS are plotted in blue and red respectively. Frontier systems are plotted in bold.

The frontier is a set of systems that best meet the PPOs, denoted by the thick black points.[22] Since core payment systems would likely be designated as either systemic or prominent by the Bank of Canada, we further limit the range of systems to include only those that can withstand the default of at least one participant (in terms of credit risk management).

We divide the remaining frontier systems into two sets, one comprising possible large-value payment systems (highlighted in blue in Figure 4) and one comprising purely retail payment systems (highlighted in red in Figure 4). These are described in more detail in the next sections.

Figure 4: The frontier of core payment systems



Note: This plot contains all possible combinations of different attribute levels that lie on the frontier as well as the combination of attributes corresponding with the existing systems of LVTS and ACSS, which are plotted in light blue and light red respectively. All possible large-value payment systems on the frontier are plotted in blue and all possible retail payment systems on the frontier are plotted in red.

[22] This "thick" frontier was calculated by first taking the models in the frontier and then adding the models that would be the frontier if this set of models were removed.

5.1 Frontier systems that improve on the Large Value Transfer System

We examine large-value payment systems (LVPSs) on the frontier that improve on at least one PPO and are at least the same level for other PPOs as the LVTS; that is, we examine systems that are as high as and to the right of the blue LVTS point in Figure 4.

Like the LVTS, all of these system designs

- meet internationally recognized standards for credit risk (high risk management);[23] and
- provide real-time finality (i.e., high timeliness).

Unlike the LVTS, however, all of these systems ***have a high level of functionality***. This includes benefits to end-users as well as to system participants, functions that help system participants to control their credit and liquidity risk. It also implies provision of richer messaging and remittance information.[24]

The systems on the frontier ***differ in their levels of interoperability and access***.

Two thirds of the systems have the highest level of interoperability. According to our definitions, this implies the possibility of direct links between financial market infrastructures in the LVPS and in other systems such as central counterparties, security settlement systems and foreign exchange settlement systems (e.g., the CLS Bank). This interoperability also allows for links to participants' back-office systems for increased automation of payment processing such as STP.

All levels of access are possible on the frontier. Without additional guidance from regulators and stakeholders, access could be as open as having non-financial corporations participating in the LVPS or as restrictive as only deposit-taking institutions being members of the system (conditional on meeting risk-management standards). This implies that there is a safety-efficiency trade-off between different levels of access and that the ultimate maximum level of access depends on risk management in the LVPS.

One interesting finding is that approximately ***the same point on the frontier can sometimes be achieved through different combinations of system access and interoperability, all else constant***. For example, the reduction in efficiency that would otherwise emerge from a decline in interoperability can be offset by enhanced access, and vice-versa.

5.2 Frontier systems that improve on the Automated Clearing Settlement System

ACSS was created in the early 1980s and, therefore, there are many options for improvement.

For retail systems, the relevant parts of the frontier are those in blue (the LVPS frontier) and the lower red cluster in Figure 4. This is for two reasons.

---

[23] The CPMI-IOSCO Principles for Financial Market Infrastructures.

[24] See the Appendix for the definition of functionality.

First, these systems are those that have sufficiently high credit risk management to meet proposed risk standards for a prominent payment system.[25] Second, given that retail systems typically put a higher weight on efficiency than do LVPSs, we look at systems that are at least as efficient as LVPSs.

Since we have already discussed the blue part of the frontier, we focus here on systems on the lower red frontier. These systems have many attributes in common.

All have ***high levels of access***. Access is "very high" when non-financial corporations, in addition to all other payment-related firms, directly access the core retail payment systems; it is "high" when financial institutions (FIs) and other non-FI payment system providers are allowed to participate.

All have ***high levels of interoperability*** inherent, for example, in increased connections to the back-office systems of payment system participants. This interconnection allows for STP as well as increased integration with other systems.

There is a complementarity between access and interoperability. The more participants that integrate their back-office systems with the retail payments system, the more automation and the more potential for innovative integrated payments system products. This complementarity supports the higher level of efficiency.

As for LVPSs, all the systems have a ***high level of functionality***. For retail systems, this could translate into the ability to offer value-added services in addition to payment services (e.g., attaching invoicing information and other information to the payment) and centralizing common back-office services (such as some fraud or AML reporting functions) for cost-saving efficiencies.

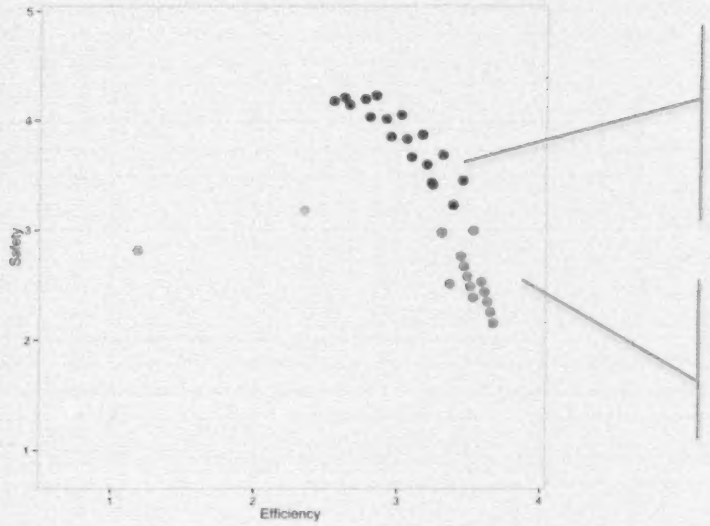
Where the frontier systems differ most is in timeliness—systems on the frontier exhibit the full ***range of options regarding timing of availability of funds*** reflecting a trade-off between efficiency and safety. On the one hand, for given risk controls, a shorter duration exposes payment system participants to lower counterparty credit risk and thus increases safety. On the other hand, a shorter duration reduces the scope for batching and netting of payments (and therefore, increases the costs of payments in terms of collateral and other costs, reducing efficiency) and reduces the scope for value-added services such as AML and fraud detection processes.

[25] The Bank of Canada has been given the authority to oversee systems that have the potential to pose "payment system risk" as well as systems that pose "systemic risk." The ACSS is likely to meet the criteria of a prominent system. See Bank of Canada (2015) for more on the Bank's proposed risk-management standards.

6. Discussion—Key Areas of Investigation

As the CPA embarks on its modernization initiative, there are myriad design options for a core payment system; the above approach helps sort through the choices in a rigorous manner. Using the analytic framework, we recommend key areas of investigation, summed up in Figure 5, that will best position the CPA to design a core payment system that meets the public policy objectives and, thereby, the needs of Canadians.

Figure 5: Summary of results



- High functionality
- High timeliness
- High risk management
- A range of interoperability and access

- High functionality
- High access
- High interoperability
- A range of timeliness

Note: This plot contains all possible combinations of different attribute levels that correspond with those that merit further investigation as well as the existing systems of LVTS and ACSS, which are plotted in light blue and light red respectively. Large-value system alternatives are plotted in blue and retail system alternatives are plotted in red.

6.1 How can the core payment system best enable rich functionality going forward?

Systems that best achieve the public policy objectives (that is, systems that are on the frontier) ***enable rich functionality***. For example, they may have the ability to provide value-added services such as rich messaging, modern queuing mechanisms and centralized services that allow the back offices of participants to be more efficient. Establishing this functionality has two implications.

First, not surprisingly, the CPA should focus on identifying the most relevant value-added services for the Canadian payments ecosystem. That is, it should identify the most important user demands and consider how the core payment system could best support these services. It is more challenging for the CPA to consider what services it should provide beyond the minimum definition of "core." We defined a core payment system as one that provides *at least* clearing and settlement. This does not preclude providing other services (such as facilitating payments exchange) if it is more efficient for those services to be provided by a centralized clearing organization (i.e., through collaboration) than through competition. The challenge for the CPA will be to identify those services.

Second, in order to stay on the frontier over time, the next generation of core payment systems should be designed in such a way that they continue to be effective in an evolving payments landscape. That is, given rapidly evolving technological advances, the CPA will need to consider how best to design the core so that it can support innovation over time and thereby remain on the frontier longer. This could be through technology but also through principles-based rules that allow for innovation.

6.2 How can access to the core system and interoperability best enhance efficiency for a given level of safety?

The same point on the frontier can be achieved through different combinations of system access and interoperability, all else constant. For example, the reduction in efficiency that would otherwise emerge from a decline in interoperability can be offset by enhanced access, and vice-versa.

Given that the payments ecosystem is changing rapidly with new players entering the retail payment space, the CPA will need to consider how to best enhance efficiency through access and interoperability for a given level of safety. As part of this investigation, it would be useful to understand what new entrants (in particular non-banks) want from the core payment systems, what their needs for services are and how those needs could be addressed in an efficient way (i.e., a system that appropriately fosters competition for a given level of safety). For example, does a lack of access or interoperability inhibit new entrants from innovating? Or can the innovation occur through those participants that do have access and/or interoperability?

6.3 Where is enhanced timeliness of payments needed, and how can it most efficiently be provided?

Our analytical framework suggests that, for retail systems, designs that sit on the frontier can support varying degrees of timeliness of payments. Timeliness is important because, in many jurisdictions, a driver of modernization has been a desire for "faster payments." Our work suggests that a system can be on the frontier with different levels of timeliness. Perhaps this is not a surprise—many business-to-business payments, for example, would not necessarily benefit from real-time finality since their payment origination is a function of such things as trade credit rather than the need for real-time finality. As well, consumers may value real-time finality for certain payments, but not others.

There is also an interaction between timeliness and functionality. The "faster" the payment (that is, the shorter the time from origination to irrevocable availability), the less time there is to provide value-added services such as AML or fraud detection processes.

It will therefore be important for the CPA to understand where there is a real demand currently and potential demand in the future for more timely payments in the Canadian context, where the functionality trade-offs are, and how to best position new core systems to meet the public policy objectives.

In addition, it will be important to understand *how* timeliness can best be provided. In our analysis, we focus on the duration from origination until irrevocable availability also referred to as

finality. To some, this is synonymous with "settlement across central bank books." However, the CPA will need to consider whether other types of arrangements would be appropriate to provide finality and whether the service must be provided within the core or whether it could be provided through other non-CPA private payment schemes.

In other words, as with functionality, the CPA needs to consider what services need to be provided by the core payment system in order to most efficiently meet the public policy objectives and which can be provided by scheme operators other than the CPA.

6.4 What does the architectural design of a Canadian core payment system on the frontier look like?

This paper is neutral regarding the "structural schema" of the core payment system; by this, we mean the arrangement of the infrastructure itself, for example, whether the core payment system should be centralized or decentralized, or whether there should be one system or separate systems for wholesale and retail payments. The structural schema has implications for the attributes—it can be a way to address certain desired attributes or public policy objectives. For example, a decentralized system naturally lends itself to lower access to the clearings since the marginal cost of adding a new participant is high relative to a centralized system. This would tend to decrease efficiency; however, this could be offset by efficiency gains through increased netting capacity.

As the CPA determines the desired attributes, there will be implications for the structural schema.

7. Conclusion

The Canadian Payments Association (CPA) is on a path to modernize Canada's core payment systems. Given that these systems underpin the Canadian financial system and economy, the CPA has a legislative mandate to operate these systems in way that meets the Canadian public policy objectives of safety and soundness, efficiency and meeting the needs of users.

As part of the modernization initiative, the CPA is developing a shared vision for the future of the Canadian payments ecosystem with CPA member institutions, payment system users and service providers. The areas of investigation recommended here based on the analytical framework will support the CPA in its engagement with these stakeholders and position the CPA to design a core payment system that meets the public policy objectives and, thereby, the needs of Canadians.

References

Berger, Allen N., Diana Hancock and Jeffrey C. Marquardt. "A Framework for Analyzing Efficiency, Risks, Costs, and Innovations in the Payments System." *Journal of Money, Credit, and Banking* 28 (4)(1996): 696–732.

Bank of Canada. "Proposed Criteria and Risk-Management Standards for Prominent Payment Systems." Available at http://www.bankofcanada.ca/wp-content/uploads/2015/06/proposed-criteria-risk-management-standards.pdf, 2015.

Canadian Payments Association. "2014 Environmental Scan: Global Trends, Challenges, and Impacts on Canada," 2014.

Canadian Payments Association. "Canadian Payments Association Launches Initiative to Support Modernization of Canada's Payments System." Available at https://www.cdnpay.ca/imis15/eng/Publications/News/eng/res/ns/CPA_Launches_Initiative_to_Support_Modernization_of_Canada_Payments_System.aspx, 2015.

Committee on Payment and Settlement Systems and the Technical Committee of the International Organization of Securities Commissions (CPSS-IOSCO). "Principles for Financial Market Infrastructures," 2012.

Department of Finance Canada. *Balancing Innovation and Oversight in the Ways We Pay: A Consultation Paper.* Available at http://www.fin.gc.ca/activty/consult/onps-ssnp-eng.asp, 2015.

Gorton, Gary B. *Slapped by the Invisible Hand: The Panic of 2007.* New York, NY: Oxford University Press, 2010.

Appendix

Tables A1–A5: Detailed Discussion of Defining Attributes

The five attributes of a core payment system are described further in tables A1 to A5 below. In each table, a high-level description of the attribute is provided, coupled with minimum requirements that apply to the attribute. These requirements should be embedded in any modernization of the core payment systems because they stem from either minimum regulatory requirements or technological constraints. They are nevertheless positioned at a level at which they can be operationalized in different ways. Each table also provides certain option-based design considerations for an attribute, as well as a list of **possible** design options for each of these considerations.[26]

Table A1: Description of access

General description	
Access refers to the minimum conditions in addition to membership in the Canadian Payments Association (e.g., legal, financial, technical, operational) that an entity would need to satisfy in order to participate directly (or indirectly) in the core payment system. Access criteria may differ according to the function performed; e.g., access criteria to the exchange or clearing may be more lenient than access to the settlement function.	
Baseline requirements	
- Access should be based on objective, risk-based criteria.	
Option-based design considerations	**Design options**
1. Participant types	(1) Banks (2) (1) + Non-bank deposit-taking institutions (DTIs) (3) (2) + Non-deposit-taking financial institutions (4) (3) + Payment service providers (5) (4) + Non-financial corporations
2. Participation structure	(1) Single structure (i.e., only direct participation allowed) (2) Tiered structure

[26] It is reasonable to assume that other lists of design options could be created to accompany each consideration. The design options in tables A1 to A5 serve as an example, reflecting the consideration and judgment of the Working Group.

Table A2: Description of functionality

General description

Functionality refers to the features embedded in the service offering of the core payment system. In line with the definition of the core, provision of value-added services described under this attribute would be warranted where it is deemed that some form of market failure precludes private industry from developing its own solution. That is, there would need to be a clear business case for why the core is providing these services.

Baseline requirements

- The infrastructure's operational risk-management framework will accommodate periodic review and renewal of system technology, physical and information technology security controls and regular risk assessments, back-up and redundancy facilities, and business continuity planning and disaster recovery testing (i.e., formal "stress-testing" capacity).

Option-based design considerations	Design options
1. Clearing format	(1) Batch-based process only (2) Individual credit transfers only (3) Combination of batch-based and individual credit transfer
2. Value-added services Examples: (i) File sorting, routing and validation (ii) Account checking (iii) Error notification and correction (iv) Anti-money laundering and fraud detection	(1) Lean (2) Moderate (3) Rich
3. Use of central queuing and optimization (wholesale infrastructure only)	(1) Yes (2) No

Table A3: Description of interoperability

General description	
At a general level, interoperability refers to the degree of compatibility between the core payment system and other external systems or schemes (including participant back-office systems) in carrying out the payments process. Interoperability has a domestic and international dimension.	
Baseline requirements - The core payment system should be easily extensible from a technology perspective and should not limit the CPA's ability to accommodate new payment types that meet minimum requirements, i.e., the system should be "future-proofed" to effectively foster competition, innovation and ubiquity in the market for end-user payments services. - A common messaging standard will be used—based on ISO 20022 standards—that will enable richer information capacity and help to facilitate straight-through processing (STP) and the system's ability to accommodate future payment types.[27]	
Option-based design considerations	**Design options**
1. Domestic interoperability[28]	(1) Low, e.g., manual entry of items into clearings, no automated link between the exchange of instructions and the clearing facility, no STP (2) Moderate, e.g., automated interface between core payment system and participant back-office systems to support STP among direct clearers; automated link between the exchange of instructions and the clearing facility; and automated posting of final balances from the core payment system to the settlement facility, if applicable (3) High, e.g., automated interface between infrastructure and participant back-office systems and between participant back offices and end-users (i.e., funds availability) to support full STP; automated link between the exchange of instructions and the clearing facility; and automated posting of final balances from the core payment system to the settlement facility, if applicable
2. International interoperability	(1) Low, e.g., a predominantly correspondent banking channel for cross-border exchange, clearing and settlement of payments (2) Moderate, e.g., linking the core payment system to foreign financial market infrastructures (FMIs) through a gateway (e.g., domestic bank as a point of entry) (3) High, e.g., direct link with foreign FMIs to allow virtually seamless processing and clearing of cross-border payments

[27] It is acknowledged that electronic cheque image exchange currently uses a different standard (ANSI X9) and this is unlikely to change with the introduction of ISO 20022 in Canada.

[28] An alternative characterization of implementation options under this characteristic could involve differing levels of STP capacity by payment type: (Low)—no STP capacity for any payment type; (Moderate)—STP capacity for some payment types (e.g., point-of-sale and wire); and (High)—STP capacity for all payment types.

Table A4: Description of timeliness of payment

General description	
Timeliness of payment refers to the time between initiation of a payment and when funds can be made available to the final recipient on an irrevocable basis, according to the infrastructure rules and not prevailing business practice.	
Baseline requirements - The core payment system will support commonality of processing standards and rules to be applied to similar payment instruments, with respect to the following: (i) Time frames for payment **exchange** (if embedded in the core) and for entry into the clearings. (ii) Time frames for **notification** around receipt of instruction and **confirmation** of receipt to end-users. (iii) Payment **return** time frames.[29]	
Option-based design considerations	**Design options**
1. Timing of funds availability	(1) T+2 or later (2) Next day (3) Same day (4) Intraday, periodic (5) Real time or near real time
2. Availability/hours of operation for payments exchange	(1) Low, e.g., 12x5 (2) Moderate, e.g., 24x5 (3) High, e.g., 24x7
3. Availability/hours of operation for payments clearing	(1) Low, e.g., 12x5 (2) Moderate, e.g., 24x5 (3) High, e.g., 24x7

[29] It may even be possible to incorporate some elements related to this as a technology solution within the core payment system; e.g., a new system could be designed to block late returns based on the reason for return and how many days have elapsed since the original exchange date or value date. Such functionality would generally be limited to debits and would not apply to instructions sent in error.

Table A5: Description of risk management

General description	
Risk management refers to the technology, rules, guidelines and other processes used to appropriately identify, assess and control risk across all functions of the infrastructure.	
Baseline requirements - The infrastructure will have a well-founded legal framework that affords clarity and certainty of participant rights and obligations and, to the extent possible, the rights and obligations of end-users. - The infrastructure will be resilient to participant default and, at a minimum, will meet overall requirements for risk management (e.g., settlement, operational and legal risk) as outlined by Bank of Canada oversight standards for systemically important and prominent payment systems. - The infrastructure will use, as appropriate, a range of system-wide monitoring tools, including transaction volumes and trends available *by instrument type*; participants' compliance with system rules; and other risk-management tools to help monitor, manage and mitigate settlement (e.g., credit, liquidity and operational risk).[30] Consistent with the Principles for Financial Market Infrastructures, this would include routine monitoring of the activity of indirect participants, as appropriate (if a tiered participation structure is accepted).	
Option-based design considerations	**Design options**
1. Settlement type	(1) Deferred net settlement (DNS) (2) Real-time gross settlement (RTGS)
2. Settlement frequency	(1) Next day or later (2) Same day (3) Intraday, periodic (4) Real time or near real time
3. Intraday credit availability to direct participants Examples: (i) Public or private provision (ii) Repurchase, pledge or other (iii) Subject to limits (iv) Collateralized/priced (v) Collateral eligibility	(1) Low availability (2) Moderate availability (3) High availability

[30] For example, the core payment system is expected to facilitate real-time bilateral and multilateral position monitoring to better manage losses associated with participant default in the system.